Turkish Journal of Primary Education (TUJPED), 2020, ***5*** (2), 183-193

The Effect of Simulation and Animation Supported 5E Model on Science Achievement and Motivation of Prospective Classroom Teachers

Yunus Emre ÖNER [1] & Süleyman YAMAN [2]

[1] *Şehit Recep İnce İmam Hatip Ortaokulu, Suluova/Amasya, Türkiye*
[2] *Samsun Ondokuz Mayıs Üniversitesi, Türkiye*

Gönderilme Tarihi (Received): 11/11/2020
Düzeltme Tarihi (Revised): 24/11/2020
Kabul Tarihi (Accepted): 03/12/2020

Abstract

This study aims to investigate the effect of simulation and animation based 5E learning cycle model on prospective teachers' success in science and on their level of motivation. The sample consisted of 46 prospective teachers studying in their second year in the department of classroom teaching in a state university in 2015-2016. The study was performed in a quasi-experiment pattern design including an experimental group and a control group. Simulation and animation based 5E model was applied to the experimental group while general methods according to the program were applied to the control group. The test of success in science and instructional materials motivation survey were performed to collect data. According to the results, there was a significant difference between the scores of science achievement and motivation in favor of the experimental group in terms of both post-test and retention scores. As for the highlights of the results could be argued that they make abstract concepts of sciences concrete, help students accurately picture and structure abstract concepts of sciences in their mind. In addition, simulation and animation, which are computer-based teaching methods, should be utilized to diversify education and training given how common distance learning is nowadays.

Keywords: *5E learning cycle model, motion, science achievement, simulation, animation.*

Simülasyon ve Animasyon Destekli 5E Modelinin Sınıf Öğretmen Adaylarının Fen Başarısı ve Motivasyonlarına Etkisi

Özet

Bu çalışmanın amacı, simülasyon ve animasyon destekli 5E öğrenme döngüsü modeli uygulamasının öğretmen adaylarının fen başarısı ve motivasyon düzeyleri üzerindeki etkisini araştırmaktır. Araştırmanın çalışma grubu 2015-2016 tarihlerinde bir devlet üniversitesinin eğitim fakültesi sınıf eğitimi programı ikinci sınıfında öğrenim gören 46 öğretmen adayından oluşmaktadır. Çalışma bir deney grubu ve bir kontrol grubunun katıldığı yarı deneysel desenle gerçekleştirilmiştir. Deney grubuna simülasyon ve animasyonla desteklenmiş 5E modeli uygulanırken kontrol grubuna programa uygun genel yöntemler uygulanmıştır. Çalışmada veriler fen başarı testi ile öğretim materyalleri motivasyon anketinden toplanmıştır. Sonuçlar incelendiğinde deney ve kontrol gruplarının fen başarısı ve motivasyon puanları arasında hem son-test hem de kalıcılık puanları açısından deney grubu lehine manidar bir farklılık görülmüştür. Bu çalışmada ön plana çıkan hususlar ifade edilecek olunursa; soyut fen konularını somutlaştırır, soyut fen kavramlarını öğrencinin zihinlerinde doğru bir şekilde canlandırmasına ve yapılandırmasına katkı sağlar. Ayrıca günümüzde uzaktan eğitimin çok yaygın kullanıldığı göz önüne alınırsa eğitim ve öğretimi zenginleştirmek için bilgisayarla öğretim tekniklerinden olan simülasyon ile animasyon kullanılmalıdır.

Anahtar kelimeler: *5E öğrenme döngüsü modeli, hareket, fen başarısı, simülasyon, animasyon.*

*Sorumlu Yazar: E-mail: oneryunusemre@gmail.com
Orcid No: 0000-0003-3063-2845

INTRODUCTION

Science and technology are an inseparable whole. Any development in sciences affects technology and boosts the developmental level of countries. Therefore, countries analyze science programs and try to create and implement programs intended to have access to scientific knowledge rather than having them memorized (Erden, 1998). Developments in this sense came into effect upon reforms introduced on science programs in 2000, 2005, 2013 and 2018, and they are currently ongoing (The Ministry of National Education - MoNE, 2018). The developments have made investments in technology ever-lasting, as well. MoNE has been making relentless investments in an effort to promote the use of technology in education and training based on current developments. One of those investments is the project initiated as a pilot practice back in 2012 called Movement to Increase Opportunities and Technology (FATIH). As a part of the FATIH project, plans were put in place to make sure that all classrooms across Turkey were equipped with LCD interactive boards and students and teachers were provided with tablet PCs (Pamuk, Çakır, Ergun, Yılmaz & Ayas, 2013). The reason behind the aforementioned efforts is the fact that Turkey now ranks among top powerful countries in the ever-changing world as information technologies are rapidly evolving.

Given the fact that science and technology directly affect almost every discipline, both individuals and governments exert vigorous efforts and make large-scale investments to keep up with the ever-competitive world. Educational software, simulation, animation, graphic organizers, e-books, digital educational games, QR codes, virtual reality, augmented reality and 3-D printers can serve as an example for educational investments (Çakır & Keleş, 2018). Countries must organize their instructional environment to keep up with changes. Computers, interactive boards, tablet PCs and multimedia (visual presentation through simultaneous use of audio, video, simulation, animation or graphs) are utilized in Turkey for in-class use of technology (Adıgüzel, Gürbulak & Sarıçayır, 2011). Additionally, QR codes, e-books, educational software and games are utilized and developed. The access to knowledge provided for students through such in-class technologies makes it easier to deliver a presentation and establish a setting to comprehend abstract concepts.

A science course is one of the means where educational technologies are utilized the most for the concretization of information. This is because sciences are far-reaching disciplines that comprise physics, chemistry, biology, geology and astronomy, and they are the disciplines where abstract concepts are more common. In addition, these disciplines are intertwined with one another. It has been long known that students have difficulty in learning sciences compared to many other disciplines and they tend to be less successful in them (Yaman, 2005). Additionally, studies suggest that students struggle with to use their knowledge in their life upon graduation to deal with problems (Ayas & Özmen, 1998; Özmen, İbrahimoğlu & Ayas, 2000). These characteristics of sciences cause course subjects to be complicated and make them the most difficult courses for students. Physics is one of the sciences where students have difficulty in learning (Yücel, 2013; Karamustafaoğlu, 2007).

The rate of success for students taking science courses is low especially in physics (Eryılmaz & Kırmızı, 2002; Kızılcık & Ünsal, 2008). The reason behind their failure is the fact that students cannot make sense out of abstract concepts in their mind. This is because the comprehension of abstract concepts is more difficult than the comprehension of concrete concepts. Learning about some knowledge that correspond to something for all age groups in real life or something that one can see or touch is easier than learning about knowledge solely explained or described. In addition, the percentage of students for conceptual mistakes, incomplete and wrong comprehension is lower than that of abstract ones. The more abstract concepts are in teaching, the less likely students succeed in sciences, and the less motivation they have because of underachievement.

Computer-based learning (CBL) offers effective solutions for such adversities. CBL is a concept that refers to the use of computer software in an educational environment for educational purposes. CBL provides students with access to course contents on a computer. In this case, teachers rather serve as a guide and makes sure that students are actively involved (Şahin & Yıldırım, 1999). Simulation and animation are CBL instruments to help students take an active part in learning process. This is because experiments, which are difficult or impossible to perform, can be brought to an educational environment thanks to animation and simulation. Experiments difficult and hazardous to be perform can be performed through animation and simulation. Animation and simulation are brought to an instructional environment through a computer and they help students observe experimental setups and achieve concrete learning (İşman, Baytekin, Balkan, Horzum & Kıyıcı, 2002). In addition, such practices contribute to any instructional environment in various aspects such as cost, time, safety and motivation (Tekdal, 2002).

5E model, one of the learning-cycle approaches, is one the most effective means to provide such practices in science courses. 5E model is the most popular learning cycle. This model was formed by the addition of 2 new phases to 3-phase learning cycle by Karplus. With focus on students, 5E model comprises phases of "engage, explore, explain, elaborate and evaluate" (Yaman, 2018). As a part of 5E model, students make active use of information and find answers to questions they face. In addition, their enthusiasm for research and curiosity are heightened. Additionally, this is favorable to create a setting that would improve a student's sense of responsibility (Çepni, Akdeniz & Keser, 2000). CBL and 5E model have so much in common. With reference to the relation between the two, Hounshell and Hill (1989) argue that simulation and animation, which are the most popular programs of CBL, provide students with a learning environment that they can be actively involved in.

There are studies over the constructive approach coupled with simulation and animation to teach sciences. These studies were performed over subjects such as success in sciences (Akkağıt, 2014; Barani, 2014; Boyacı, 2016), permanence (Köklü, 2015), attitude (Göktürk, 2015; Kahraman 2013), motivation (Limniou, Roberts & Papadopoulos, 2008; Öztürk, 2015), scientific process skills (Daşdemir, 2012) and misconceptions (Yakışan, 2008). Of them, there is no study that deals with th entirety of the motion subject where both 5E and simulation-animation are utilized., The aim of the study is to reveal the effect of simulation and animation based 5E model on prospective teachers' success in sciences for the subject of motion and their level of motivation.

METHOD

A quasi-experimental method was adopted with a pre and post-test control group as a part of the study. The quasi-experimental method is a significant alternative in case random assignments cannot be performed. The quasi experimental method allows for matching two groups based on certain variables. The matched groups are randomly assigned as experimental and control groups. This does not guarantee that the groups in the study are equivalent to one another (Büyüköztürk, Akgün, Çakmak, Karadeniz & Demirel, 2014). In this study, whether both groups are equivalent was included in a pre-test to mitigate this limitation.

Study Group

The population of the study consisted of the prospective teachers studying as a sophomore in the department of classroom training of the faculty of education in a state university located in a medium-sized city of the Central Black Sea Region in 2015-2016. The subjects were 46 prospective classroom teachers including 24 in the experimental group and 22 in the control group. The purposeful sampling approach was used in this study. While creating the study

group, the department of classroom training was chosen due to the sufficient number of prospective teachers.

Data Collection Tools

The prospective teachers' success in science for motion was measured by a science success test by the researcher. A unit was designated, and a table of specifications was drafted to prepare the test of success in sciences. In addition, a repository of questions was created for the success test in line with the views of two domain and assessment-evaluation experts. The preliminary version of the 46-item test was disseminated among 167 prospective teachers. 21 items, which remained below 0.20 in discrimination index as a result of pre-testing, were excluded from the test and the number of items in the test was reduced to 25. Kuder-Richardson reliability coefficient turned out to be 0.71 for the tool of measurement deemed to be sufficient for the content validity after being checked by two domain and assessment-evaluation experts. The prospective teachers' level of motivation for instructional materials was measured by the Instructional Materials Motivation Survey (IMMS) developed by Keller (1987) and adapted into Turkish by Kutu and Sözbilir (2011). The reliability coefficient of the survey, which is composed of 24 items in total, was equal to 0.83. Cronbach's Alpha reliability coefficient turned out to be 0.96 based on results of the analysis of the data collected for this study.

Phases

The phases of this survey were presented in 3 phases as follows:

Pre-Experimental Design

The scope of the motion unit was identified in line with the use of simulation and animation. The main concepts of this unit were designated based on attainments in the book titled Scientific Principles of General Physics and Technology (Orbay & Öner, 2015). The motion unit covers subjects of "Motion, Relocation", "Speed and Momentum", "Regression Motion", "Pulsating Direct Motion", "One-Dimensional Motion", "Two-Dimensional (Planar) Motion", and "Relative Motion".

A success test was developed, and a survey to perform pre-tests and post-tests was drawn up, and necessary permits were granted. The validation and reliability actions were taken for the success test. The measurement tools were adopted as a test and a survey pre-test at a course prior to the inception of the study.

Experimental Study

General methods according to the program were adopted for the control group over for two hours in four weeks, with the focus being on direct instruction, question-answer and demonstration-having it done. For the experimental group, the same lecturer implemented practices assisted by animation and simulation based on the learning cycle (5E Model) for two hours in four weeks in physics lesson.

The lecturer is an expert with a master's degree, teaching the same course for more than 25 years. The practices of the lecturer for both groups were observed by another lecturer who works for the same institution in the same discipline.

In the initial phase of 5E model, the attention of the experimental group was drawn to the subject through animation. During exploration phase, the experimental group was allowed to perform operations on a computer through simulation and modify data. In fact, the group was left alone and they helped each other. In the phase of explanation, the teacher lectures on the course. Simulation and animation made it possible to bring experiments difficult or impossible to perform (animation to drop a coconut by a rifle, simulation of cannon shots for projectile

motion, simulation of bullet motion in horizontal fire etc.) to instructional environment, and provided the experimental group with concrete experiences. Some laboratory activities to enable them to put their knowledge and skills into effect were performed in the phase of elaboration. The experimental group was brought to a laboratory of introduction to physics and made to perform experiments about the subjects in smaller groups. The experimental group was asked to give examples based on daily life. In the phase of evaluation, post-tests were performed by the end of the course to measure their level of knowledge about subjects.

Post-Experimental Design

As a final step, the permanence test was performed four weeks after the end of the course.

Data Analysis

Prior to any data analysis, the data were checked, and extreme data at scales were cleared, and black data were replaced by statistical data to put them in order. In the next phase, whether data sets had a normal distribution was tested. The skewness and kurtosis of data collected were checked. The skewness of the data sets ranged from -1 to +1 for the groups compared. Based on the graphs, it was concluded that the data sets had a near-normal distribution (Büyüköztürk, 2017). Levene test was performed to identify how homogeneous variances were. Levene tests revealed that the group variances were homogeneous (p>0.05). As a result, parametric statistics were used for data analysis as the variances had a normal distribution in the groups and they were homogeneous. The level of significant for the parametric statistics was designated as 0.05.

RESULTS

This chapter provides analyses over scores of sciences achievement and motivation for prospective teachers based on simulation and animation based 5E model with general methods according to the program.

Table 1. T-Test Results for Independent Groups on Pre-Test and Post-Test Scores Concerning Science Success

Test	Group	N	$\bar{X}$	S	sd	t	p
Pre-test	Experimental	24	6.83	2.78	44	0.85	0.40
	Control	22	6.23	1.97			
Post-test	Experimental	24	13.38	2.16	44	4.16	0.00
	Control	22	10.86	1.91			

Based on the mean pre-test scores in Table 1, the mean score of the experimental group for success in sciences turned out to be 6.83 while the mean score of the control group was 6.23. Once the standard deviation scores were analyzed, it was concluded that the pre-test scores of the prospective teachers in the experimental group were more heterogeneous than the scores of the control group. Based on these results, no significant difference was identified between the experimental and control group in terms of their scores of sciences achievement prior to the experimental study. Based on the mean post-test scores of the groups, the mean score of the experimental group for success in sciences turned out to be 13.38 while the mean score of the

control group was 10.86. In addition, it was determined by the end of practice that the scores of the prospective teachers in the control group were more homogeneous. The results revealed a significant difference between the science success scores of the experimental and control groups in favor of the experimental group ($t_{(44)}$=4.16; p<0.05).

Table 2. T-Test Results for Independent Groups on Permanence Scores Concerning Science Success

Group	N	$\bar{X}$	S	sd	t	p
Experimental	24	9.63	3.26	44	3.28	0.002
Control	22	7.05	1.81			

Table 2 shows that the mean permanence score for success in sciences was 9.63 for the experimental group and 7.05 for the control group. Table also shows that the scores of the control group were more homogeneous. Based on these results, there was a significant difference between the experimental group and the control group in favor of the experimental group for their permanence scores of success in sciences ($t_{(44)}$=3.28; p<0.05).

Table 3. T-Test Results for Independent Groups on IMMS Pre-Test and Post-Test Scores

Test	**Group**	**N**	$\bar{X}$	**S**	**sd**	**t**	**p**
Pre-test	Experiment	24	2.45	0.57	44	1.33	0.19
	Control	22	2.64	0.32			
Post-test	Experiment	24	3.31	0.61	43	3.83	0.00
	Control	22	2.68	0.49			

Table 3 shows that the mean pre-test score of motivation turned out to be 2.45 for the experimental group, and 2.64 for the control group. Based on the results, it was concluded that there was not any significant difference between the experimental group and the control group in terms of the pre-test scores of motivation (p>0.05). The mean post-test scores of the groups were 3.31 for the experimental group and 2.68 for the control group. In addition, the scores of the control group were more homogeneous for the standard deviation. Based on these results, there was a significant difference between the experimental group and the control group in favor of the experimental group in terms of level of motivation ($t_{(43)}$=3.83; p<0.05).

DISCUSSION

Once the mean pre-test scores of the groups were analyzed based on the results of the study, it was found out that there was not any significant difference between the pre-test scores of the experimental group for which simulation and animation based 5E model was adopted, and the control group for which general methods according to the program were adopted (p>0.05). In this case, it can be stated that simulation and animation based 5E model practices are more effective than conventional methods in improving the success of prospective teachers in sciences. There are various studies that show similarity in terms of results (Gül & Yeşilyurt, 2011; Hançer & Yalçın, 2009; Kaya & Tarkın-Çelikkıran, 2020; Saka & Akdeniz, 2006). What those studies have in common is the focus on abstract concepts. In addition, the studies were

focused on subjects that make it difficult and hazardous to perform an experiment. Kahraman (2013) worked on an electric unit of sciences. Based on the results, He argued that animated movies made about subjects that concern abstract concepts and make it difficult for students to understand as they never face them in their daily life could improve their success in sciences. From a similar perspective, Akkağıt (2014) conducted a study on electric and magnetism unit and argued that simulation and animation could help students learn about subjects of physics more effectively. Barani (2014) reported as a result of a study over modern physics (quantum) that the use of animation for abstract concepts help students have an easier time to structure concepts that they would normally find difficult to understand. In addition, Gül and Yeşilyurt (2011) reported that the combination of computer-based education and a constructive approach would improve the success in sciences.

The permanence scores of the groups revealed a significant difference in favor of the experimental group (p<0.05). These results are consistent with the results of similar studies. Daşdemir (2012) addressed the buoyancy and pressure of liquids and gases as a part of a PhD dissertation. Daşdemir also argued that one can conclude animated movies presented in motion, color and audio can help students make a concrete sense of course subjects and make their knowledge permanent. In a PhD dissertation, Köklü (2015) reported that the experimental group displayed a significantly higher score than the control group for permanence based on the results. Bayram (2012) adopted a constructive approach based on animated movies for the experimental group while the course was delivered solely based on a constructive approach for the control group. The permanence test revealed that the use of animation helps making acquired knowledge permanent. In a study, Bülbül (2009) concluded that animation and simulation have a positive effect on the permanence of knowledge.

It was reported that there was no significant difference between the levels of motivation for students based on the results of a pre-test while the experimental procedure revealed a significant difference in favor of the experimental group (p<0.05). It could be noted that these results are consistent with the results of various studies. Limniou, Roberts and Papadopoulos (2008) investigated the effect of two-dimensional and realistic animation and three-dimensional virtual animation on motivation of students about chemical reactions. The results of their study suggested that the experimental group was more motivated than the control group. Based on these results, one can construe that simulation and animation appeal to more sense organs of students, draw their attention to courses and thus boost their motivation.

CONCLUSION

Sciences with abstract concepts were usually chosen for the subjects and units specified in the aforementioned examples. As for the highlights of the results of this study and the aforementioned studies, it could be argued that they make abstract concepts of sciences concrete, help students accurately picture and structure abstract concepts of sciences in their mind, provide students with platforms where they can be actively involved, and allow experiments difficult, expensive and hazardous to perform to be brought to learning environment, have images draw attention of students, and are likely to boost their motivation and environment that appeal to multiple senses and allow students to take an active part in can improve the permanence of knowledge.

To make suggestions in consideration of the results of the study, simulation and animation should be utilized particularly in the motion unit as a part of instructional environment in consideration of the effect of the environment enhanced by simulation and animation on success in sciences, motivation and permanence.

Teachers must be encouraged to use simulation and animation and provided with training if needed. Ready-made animation and simulation were utilized as a part of this study. Since it is not possible to find such tools for every subject, the provision of training for teachers can help them develop animation and simulation for their own students and these can be shared. This will enable them to create and use their own archives. In addition, simulation and animation, which are computer-based teaching methods, should be utilized to diversify education and training given how common distance learning is nowadays.

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Kaynak gösterimi için (for cite in):

Öner, Y.E. & Yaman, S. (2020). Simülasyon ve animasyon destekli 5e modelinin sınıf öğretmen adaylarının fen başarısı ve motivasyonlarına etkisi. *Turkish Journal of Primary Education (TUJPED), 5*(2), 183-193.

GENİŞ ÖZET

Giriş

Fen bilimleri ile teknoloji ayrılmaz bir bütündür. Milli Eğitim Bakanlığı (MEB) güncel gelişmeler ışığında eğitim-öğretim süreçlerinde teknoloji kullanımını artırmak amacıyla sürekli yatırımlar yapmaktadır. Bu kapsamda eğitim yatırımlarına; eğitim yazılımları, simülasyonlar, animasyonlar, grafik örgütleyiciler, e-kitap, dijital eğitsel oyunlar, karekod uygulaması, sanal gerçeklik, artırılmış gerçeklik, 3 boyutlu yazıcılar örnek verilebilir (Çakır & Keleş, 2018). Eğitim teknolojilerinin en fazla kullanıldığı alanlardan biri fen bilimleri dersidir. Öğrencilerin fen bilimlerini öğrenmede, diğer birçok alana göre güçlük yaşadıkları ve başarı düzeylerinin düşük olduğu bilinmektedir (Yaman, 2005). Fen bilimleri dersini alan öğrencilerin özellikle fizik konularında başarı oranı düşüktür (Eryılmaz ve Kırmızı, 2002; Kızılcık ve Ünsal, 2008). Bu başarısızlığın nedeni, konu kapsamındaki soyut kavramların öğrencilerin zihinlerinde anlamlı hale gelememesindendir. Öğretimde soyut kavramlar ne kadar çok ise öğrencilerin fen başarısı düşecek ve başarının düşmesine bağlı olarak bireyin motivasyonu azalacaktır (Yücel, 2013). Bilgisayar destekli öğrenme (BDÖ), bu tür olumsuzluklara yönelik etkili çözümler sunmaktadır. Simülasyon ve animasyonlar, öğrencilerin öğrenme sürecine aktif olarak katılmalarını sağlayan BDÖ araçlarıdır. Çünkü simülasyon ve animasyonlarla yapılması zor ya da mümkün olmayan deneyler öğrenme ortamına getirilebilir. Bu çalışmanın da amacı simülasyon ve animasyon destekli 5E modeli uygulamasının öğretmen adaylarının hareket konusuna yönelik fen başarıları ve motivasyon düzeyleri üzerine etkisini araştırmaktır

Yöntem

Araştırmada öntest-sontest kontrol gruplu yarı deneysel yöntem kullanılmıştır. Çalışma grubunu 2015-2016 yılında sınıf eğitimi anabilim dalı 2. sınıfta öğrenim gören 24'ü deney 22'si kontrol grubunda olmak üzere toplam 46 öğretmen adayı oluşturmaktadır. Araştırmada öğretmen adaylarının hareket konusundaki fen başarıları, araştırmacı tarafından hazırlanan fen başarı testi ile ölçülmüştür. Testin 46 maddelik ön deneme formu 167 öğretmen adaylarına uygulanmıştır. Ön uygulama sonucunda ayırt edicilik indeksi 0.20 altında kalan 21 madde testten çıkarılarak testteki madde sayısı 25'e indirilmiştir. Testin güvenirlik katsayısı 0.71 olarak tespit edilmiştir. Öğretmen adaylarının öğretim materyallerine yönelik motivasyon düzeyleri ise Keller (1987) tarafından geliştirilen, Kutu ve Sözbilir (2011) tarafından Türkçeye uyarlanan Öğretim Materyalleri Motivasyon Anketi ile ölçülmüştür. Deneysel çalışmada kontrol grubuna programa uygun genel yöntemler uygulanmıştır. Deney grubuna ise animasyon ve simülasyon ile desteklenmiş 5E modeli uygulanmıştır. Çalışma hafta ikişer saatten dört hafta sürmüştür. Son olarak ders bitiminden dört hafta sonra kalıcılık testi uygulanmıştır.

Bulgular

Bulgulara göre, deneysel çalışma öncesinde deney ve kontrol gruplarının fen başarı puanları arasında manidar bir farklılık olmadığı tespit edilmiştir. Uygulama sonrasında ise deney ve kontrol gruplarının fen başarı puanları arasında deney grubu lehine manidar bir farklılık olduğu tespit edilmiştir. Ayrıca çalışma sonrası uygulanan fen başarısı kalıcılık testinde deney grubu lehine manidar bir farklılık tespit edilmiştir Bulgulara göre, deney ve kontrol gruplarının motivasyon düzey öntest puanları arasında manidar bir farklılık olmadığı tespit edilmiştir. Uygulama sonrası deney ve kontrol gruplarının motivasyon düzeyleri arasında deney grubu lehine manidar bir farklılık meydana geldiği görülmektedir.

Tartışma ve Sonuç

Simülasyon ve animasyon ile desteklenmiş 5E modeli uygulamalarının öğretmen adaylarının fen başarılarını artırmada etkili olduğu sonucuna varılabilir. Bulunan sonuçla benzerlik gösteren farklı çalışmalar mevcuttur. Bu çalışmaların ortak yönü olarak soyut kavramların üzerinde durulması gösterilebilir. Ayrıca çalışmalar deney yapmanın zor ve tehlikeli olduğu konular üzerinde yoğunlaşmıştır. Kahraman (2013) çalışmasını fen bilimleri dersi elektrik ünitesi üzerinde yapmıştır. Elde ettiği bulgular sonucunda daha çok soyut kavramlar ve günlük yaşantıda öğrencinin karşılaşamayacağı ve dolayısıyla anlamakta güçlük çekeceği konular hakkında hazırlanan animasyonların fen başarısını artırabileceğini ifade etmiştir. Bu görüşe benzer olarak Akkağıt (2014) elektrik ve manyetizma ünitesi üzerine yaptığı çalışmada simülasyon ve animasyon kullanarak soyut fizik konularının öğrenciler tarafından daha etkin öğrenebileceğini ifade etmiştir. Limniou, Roberts ve Papadopoulos (2008), çalışmalarında kimyasal reaksiyonlar konusunda iki boyutlu gerçekçi animasyonların ve üç boyutlu sanal animasyonların öğrencilerin motivasyonlarına etkisini araştırmışlardır. Çalışma sonunda elde edilen veriler deney grubunun, kontrol grubuna göre motivasyon davranışlarının daha yüksek olduğu sonucunu ortaya koymuştur. Bu sonuçlar, simülasyon ve animasyonların öğrencilerin daha fazla duyu organına hitap ettiği, dikkatlerini derse çekerek motivasyon düzeylerini yükselttiği şeklinde değerlendirilebilir. Günümüzde uzaktan eğitimin çok yaygın kullanıldığı göz önüne alınırsa eğitim ve öğretimi zenginleştirmek için bilgisayarla öğretim tekniklerinden olan simülasyon ile animasyon kullanılmalıdır.